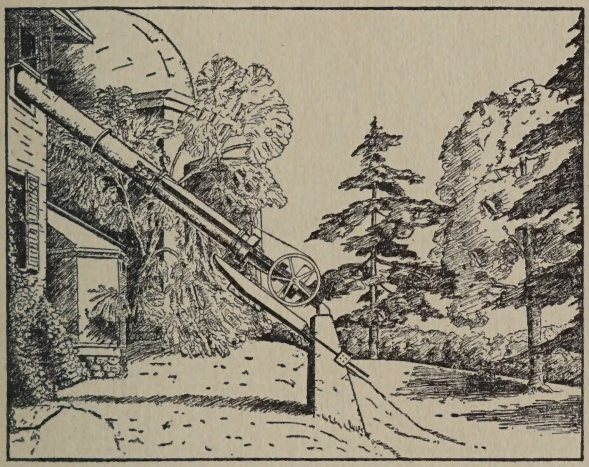
HARVARD OBSERVATORY

A BRIEF ACCOUNT OF THE HARVARD OBSERVATORY

A Brief Account of the Harvard Observatory

By

JENKA MOHR



Cambridge, Massachusetts

September 1, 1932

PRINTED AT THE HARVARD UNIVERSITY PRESS
CAMBRIDGE, MASS., U. S. A.

A BRIEF ACCOUNT OF THE HARVARD OBSERVATORY

A BRIEF ACCOUNT OF THE HARVARD OBSERVATORY

INTRODUCTION

The Harvard Observatory, one of the many departments of Harvard University, is itself composed of a number of units. Its observing stations, established in both the southern and the northern hemispheres, make possible the investigation of problems covering the entire celestial sphere. At the Cambridge headquarters the staff is engaged in numerous researches based on the material obtained at these stations. The Observatory is, in addition, closely associated with the astronomical instruction in the College and University. These various elements are organized with the purpose of achieving a systematic and consistent program of research in several astronomical fields. A descriptive outline of the different parts into which the organization is divided is presented in this booklet, with some indication of the way in which they are unified.

The Location of the Present Stations

The principal station of the Observatory is situated on a thirteen-acre tract of land in the northwest section of Cam-

bridge. Here are the offices of administration and research, the collection of photographic plates, the library, the laboratories, and a number of telescopes, both visual and photographic.

Although at the time it was chosen as the Cambridge headquarters, the site was sufficiently isolated to obtain freedom from dust and artificial lights, the location became less suitable for observing as the city of Cambridge encroached on the surrounding land. In 1931 a more isolated site at Oak Ridge in the township of Harvard, twenty-five miles northwest of Cambridge, was chosen and most of the telescopes have been moved to this new field. It is the headquarters for photography of the northern sky; all the plates are stored and studied at Cambridge.

In the southern hemisphere a station was established as early as 1890 in order that plates on the southern stars might be included in the photographic programs. A site was chosen at Arequipa, Peru, at an elevation of over eight thousand feet, and maintained there until 1926. The station was then transferred to Bloemfontein, South Africa, where there was a prospect of more suitable weather conditions for year-round photographic work. A Harvard station maintained for twelve years at Mandeville, Jamaica, is now operated as a private observatory.

In 1931 a temporary station, employing four observers, was established in Arizona for intensive meteor observation, both with and without telescope. It was located near the Lowell Observatory, in Flagstaff. In 1932 a computing bureau for the reduction of the meteor observations thus obtained was established at Tartu, Esthonia.

The Connection with Harvard University

The Observatory is officially distinct from the Department of Astronomy in the college, in which instruction is given to students; but the Director of the Observatory is also head of the Department of Astronomy, and members of the Observatory staff are the professors and instructors in that department. The Students' Astronomical Laboratory, situated on Jarvis Street, near the majority of the college buildings, is used for undergraduate classes and laboratory instruction. But all special students of astronomy are given frequent access to the equipment of the Observatory itself.

Within the past few years graduate work in the department of Astronomy has been steadily growing. The increase of the Observatory staff, and especially the addition of specialists in various fields of astronomy and astrophysics, have made possible advanced research training for graduate students. A number of graduate courses are given at the Observatory throughout the academic year; students' seminars are frequently held for the discussion of current problems; a tutorial room allows opportunity for meeting of tutors with students, and offers a place for reading and discussion among the students.

Research and Publications

The staff of the Observatory numbers about fifty-five, including astronomers and their assistants. Because of the variety of interests among these workers, and the range of available equipment, the researches undertaken at the Observatory embrace many current astronomical problems. The

various types of photographs make possible analyses of the distribution of stars and nebulae, determinations of proper motions, investigations of variable stars, discovery and study of asteroid trails. Researches on line contours and other problems of spectrophotometry are carried on extensively. The spectral classification of stars, begun many years ago, has continued in the Henry Draper Catalogue and its later Extension.

Since the inception of the Observatory, photometry has been a problem of major interest, and several researches in photographic and photovisual photometry are in progress. A number of students are engaged on problems of meteors, involving both visual and photographic observations.

Questions of the structure of our own galaxy, and of external galaxies, have increased in significance within the past few years; many of the researches now in progress are designed to bear directly on these questions. Studies are made of the contents of both the home galaxy and the nearer neighbors; and the star clusters, globular and galactic, are searched for possible clues as to the birth or the decadence of a universe.

The researches of the Observatory are published in a number of forms. The shorter reports, and those of most general interest, are published in a series of Bulletins, eight or ten of which are issued during the course of the year. The longer papers, generally involving detailed analyses of special problems, form a series of Circulars, which are issued at irregular intervals. The Reprints are assembled systematically from the various journals to which staff members contribute. More elaborate discussions and extensive tabular material such as catalogues of spectral classifications, stellar magni-

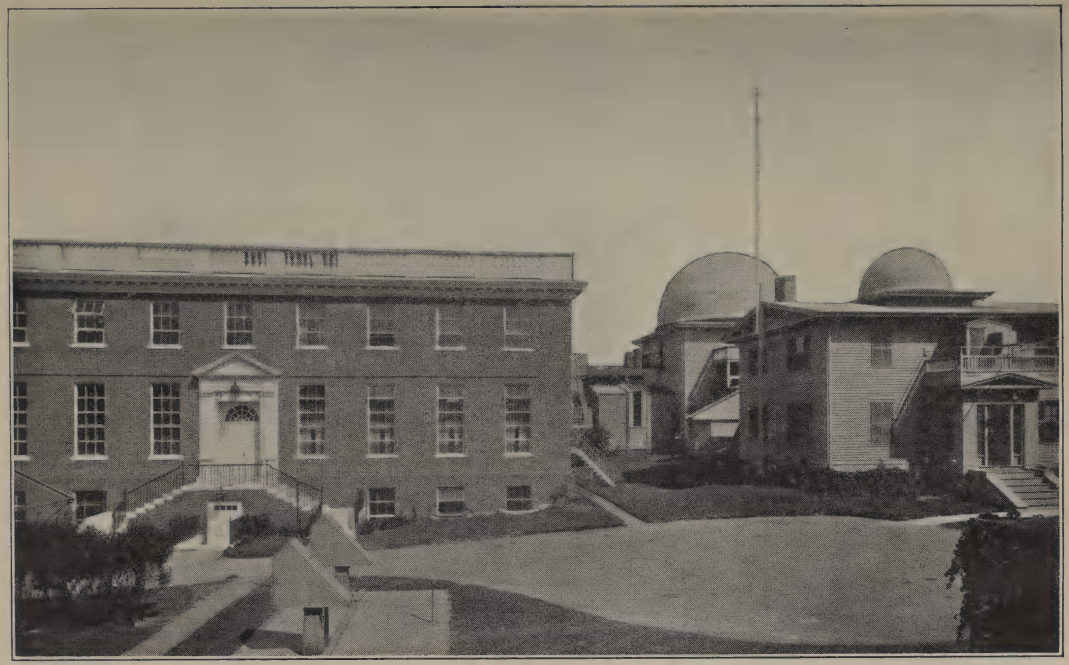


FIGURE 1. The main buildings of the Observatory in Cambridge. At the left is Building D, which contains the plate collection; at the right, Building A, with the domes of the 15-inch and 6-inch visual telescopes. In the foreground are two of the patrol cameras.

tudes, external galaxies, appear largely in the Harvard Annals. Four octavo volumes of the Harvard Observatory Monographs have been issued.

A series of Announcement Cards is distributed, giving such information on the discovery and ephemeredes of comets, asteroids, and other interesting phenomena as is important for contemporary observation. A telegraphic service for the western hemisphere, connected with the Copenhagen service in Europe, is carried on by the Observatory for the immediate dissemination of the information printed in more detail on the Announcement Cards.

A Director's Report annually summarizes the developments at the Observatory.

THE BEGINNINGS OF THE OBSERVATORY

From the founding of Harvard College in 1636, astronomy was a subject of sustained interest. Throughout the earliest years of American education it was considered an essential. The beginning of the nineteenth century saw the first attempts at Harvard to institute an astronomical observatory; but not until 1839 was its organization effective, or the financial support adequate for its maintenance. Five years later it was moved to its present site, and in 1849 it was incorporated, as a distinct department, into Harvard University, of which it has ever since been a part.

The early years of the Observatory were devoted largely to the acquisition of equipment and the formulation of problems significant for the times. The purchase of the 15-inch refractor, erected in 1847, marked an epoch in its growth. A later acquisition of almost equal importance was a large meridian circle. There has been a fairly steady increase in equipment, and a consequent growth in staff and in facilities for research.

The growth of the Observatory cannot be adequately sketched without reference to the early attack on problems of photometry, carried on visually before the development of astrophotography. Among the instruments devised at the Observatory were a number of photometers for visual use.

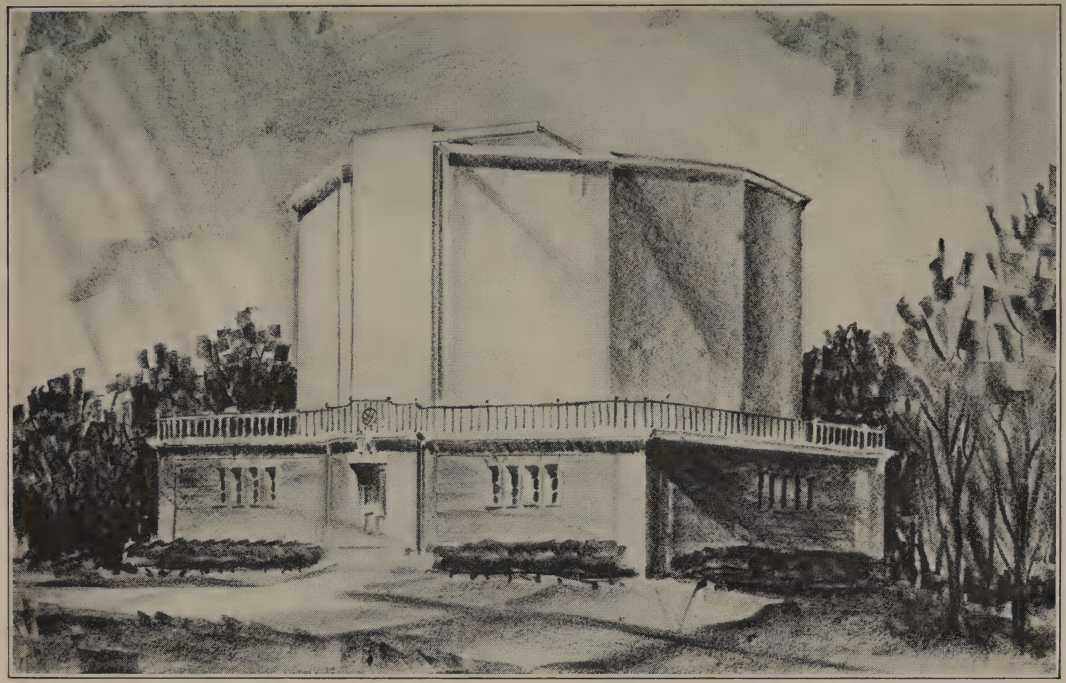


FIGURE 2. The building for the 61-inch reflector at the Oak Ridge Station.

One of the most exciting and crucial events of the first decades of the Observatory's life was the growth of photographic astronomy. The first astronomical picture, a photograph of the moon, was taken in 1840 by Dr. John Draper. It was a daguerreotype, as were all the earliest attempts. Ten years later the first picture ever taken of a star was achieved at Harvard with the 15-inch refractor. The star was Vega; and the event was soon followed by another photograph, of Castor. But astrophotography was inefficient with the technique then available. Not until the dry plate process was developed, about 1875, were the possibilities of photography in astronomy realized.

In 1882 the first photographic program was inaugurated at Harvard, and the carrying on of further surveys has continued uninterruptedly. The introduction of the camera as a substitute for the visual observer did indeed constitute a revolution, not only in astronomical methods, but inevitably in problems. With the advent of the photographic plate came technical problems of developers, emulsions, speeds of plates, the comparison of visual and photographic magnitudes. The whole field of spectroscopy widened; astrophysics advanced with remarkable strides.

Along with research problems within the Observatory, interest was developed in various expeditions. Between 1850 and 1900 six expeditions were undertaken for the observation of total solar eclipses. A number of subsidiary stations were built. After two expeditions to Peru the Arequipa station, previously mentioned, was established in 1891, and for many years it remained the southern station of Harvard Observatory. Excursions to Jamaica early in the twentieth century

resulted in the establishment of a station there in 1912. Intermittently from 1923 to 1926 a station was operated in Chuquicamata, a mining town in the desert region of northern Chile; but the inhospitality of the desert made the location inadvisable for a permanent site.

IN CAMBRIDGE

The photographs made at the various branches of the Observatory are brought for study to Cambridge — the headquarters of the organization. Of its principal structures, the oldest, Building A, was erected mainly in 1844. The central portion contains the Sears Tower for the 15-inch refractor. East of the tower is the residence of the Director. Immediately west of the tower is a large room, originally used for the 8-inch meridian circle and one or two smaller transit instruments.

At present the meridian circle room is used for exhibition purposes, containing illuminated transparencies of the various stations, interesting instruments, noteworthy sidereal objects, and graphical illustrations of the researches by the staff. Of the remaining rooms in Building A, one has recently been dedicated (1931) as a Pickering Memorial, and is used as headquarters for the American Association of Variable Star Observers; two others, and a small dome with a 6-inch refractor, are tutorial head-quarters, and still others are used as offices and library annexes.

Building B, separated from the other structures, contains the machine shop, a students' laboratory and dark room, the electric equipment for driving and controlling the photographic telescopes, and a few offices.

After the collection of photographic plates had grown to a considerable extent, a more suitable place in which to house it

was found necessary. Building C, which for many years served this purpose, was erected in 1893. Unlike the earlier buildings, it was constructed of brick. The eastern end, built in 1902 as an addition to the original structure, was necessitated by the ever-increasing collection of celestial photographs.

Although much more satisfactory for the purpose than were the wooden buildings first erected, Building C was far from adequate as a storehouse for the stellar photographs. Most of the plates were kept in wooden stacks, and much of the structure was inadequately protected against the dangers of fire and weather. For this reason, and also because of the increasingly crowded condition of the offices, Building D was erected in 1931. Connected with the west end of Building C, it furnishes sufficient room for the growth of the plate collection for the next fifty years. An outstanding feature is its four tiers of steel plate vaults, occupying two floors of the northern half. Here are not only the steel stacks in which the plates are kept, but also alcoves suitably equipped for plate examination.

The four tiers of the plate vault are built up independently of the main structure. Each tier rests on steel columns supported from below; and the cement floors, covered with asphalt tile, which support the steel plate stacks, are set in "cradles" on these columns. Thus the whole structure of the plate vault is inserted into the north half of the building. Two circular staircases connect the several floors inside this section; and the three upper tiers have access to the main hallway. Double windows protect the stacks from variations in the outer air, and a ventilating system, providing freshly

FIGURE 3. The 10-inch Metcalf telescope on Harvard Kopje, Bloemfontein.

washed air in continual circulation, maintains a reasonably constant temperature and humidity. A small elevator running up through the building permits the transference of plates from any of the tiers in the plate vault to the offices.

The south half of Building D is built in three floors. The ground floor is occupied by offices and the dark rooms and laboratory. Above is the library and auditorium; it contains the majority of the astronomical books and periodicals, with a mezzanine on which is kept the current literature. Several reading tables are on this floor. The entire third floor of the building is used for offices for research and administration.

A number of telescopes are retained in Cambridge. Building A has, in addition to the 15-inch refractor, which is housed in a large, green, copper-covered dome, a 6-inch and a 12-inch visual telescope. Several other instruments are housed in separate small buildings on the grounds. These structures, with one exception — the dome for the 11-inch Draper telescope — are built with sliding roofs that run off onto projecting metal beams.

HARVARD KOPJE

When the southern station of the Observatory was moved to the high plateau of the Orange Free State, South Africa, a site was chosen on a low hill, about fourteen miles from the city of Bloemfontein. This hill, known as Harvard Kopje, overlooks the beautiful winding Modder River. Here are situated six telescopes with which not only all of the southern sky but also regions as far north as thirty degrees above the equator may be photographed. The station is in latitude −29°.

Harvard Kopje is operated by a superintendent, aided by several assistants. The photographic program is planned at Cambridge, with the purpose of meeting the requirements of particular problems. Thus, one series of photographs gives data for studies of Milky Way variable stars. Another is devised to cover the sky with a survey of faint external galaxies. A third is a series of spectrum photographs for use in the Extension to the Henry Draper Catalogue.

The southern station is the outcome of a bequest by Uriah A. Boyden for the purpose of creating a high altitude observatory. The trustees of the Boyden Fund transferred it to Harvard College for the use of the Observatory. The station thus made possible is known as Boyden Station. Many expeditions were carried on to determine the best possible site, even after the station had been established in Peru. As early as the first decade of the present century it was decided that

FIGURE 4. The 60-inch reflector on Harvard Kopje, and the steel framework of the turret under construction. To the right of the telescope is the electrically driven observing platform, which moves on a circular track.

South Africa was the most acceptable location; but the expensive transference of telescopes and other equipment was not made until 1926. Since then the task of erecting buildings for the administration of the station and the housing of the instruments has been carried on.

The type of telescope-house used at Bloemfontein fits in very well with the topography of the country. Made of white stucco, with roofs that slide open over supporting pillars, the buildings seem architecturally suitable to the broad, flat sweep of the plateau. With the exception of the building for the 60-inch telescope, they are all of the type shown in the accompanying photograph.

Many of the photographs taken in South Africa are the complements to those made with similar instruments in the north. Thus, the patrol cameras, with 3-inch Ross lenses, cover both northern and southern hemispheres with similar series of large-field, short-focus plates. The 8-inch Bache telescope in the south and the 8-inch Draper in the north form another pair whose plates are used in innumerable ways. The 60-inch reflector in the south is paralleled by the similar 61-inch on Oak Ridge. This duplication of instruments can, of course, furnish homogenous data over the entire sky for all problems of general analysis, whether of spectral types, radial velocities, star densities, or nebular distribution.

THE OAK RIDGE STATION

With the increase of telescopic equipment, as well as with the growing northward trend of the city of Cambridge, it became imperative to obtain more and clearer space for operation. In point of view of both present needs and future growth, the Town of Harvard has been found to be the most suitable site obtainable for photographic work. Nearly forty acres of fairly heavily wooded land on Oak Ridge were given to the Observatory by Mr. and Mrs. Alfred C. Fuller of Belmont and Harvard. The progress of building, begun in the spring of 1932, has been fairly rapid, and the end of the summer of this year finds telescopes in operation.

The main administration building on Oak Ridge contains an office for keeping records of programs in progress. There are also sleeping accommodations for observers, a room for motor-generators, and a dark room. The structure is of red brick, as are the buildings for the telescopes.

The 24-inch reflector and the 16-inch doublet are in twin buildings to the north of the administration building. The concrete piers of the telescopes are set on solid rock, several feet below the concrete floors, and the roofs are of the sliding type. Another similar building is occupied by a 6½-inch visual telescope, given to the Observatory by Mrs. E. D. Roe, Jr., and known as the Roe Memorial Telescope.

The patrol cameras are placed on a high concrete platform,

situated between the 24-inch and the 16-inch telescopes. At present they are a 3-inch Ross lens, a 1-inch Cooke, and a ½-inch Voigtländer.

The Oak Ridge station furnishes also a site for the visual and telescopic observation of meteors. A small room, roofless, and placed on stilts to raise it above the surrounding trees, has been built to accommodate observer and equipment. The development of meteor photography has recently become the subject of considerable experiment, as has also the problem of obtaining meteor spectra.

The Geophysical Committee of Harvard University has found in Oak Ridge a place eminently adapted to a seismological station, and with the cooperation of the Observatory has established an underground station and laboratory not far from the telescope buildings. Its location and extensive equipment make it one of the principal seismological stations in the western hemisphere.

A feature of the Oak Ridge station is the Agassiz vacation cottage, the gift of Mr. George Agassiz. The cottage was built to enable members of the Observatory to take advantage of the recreational opportunities afforded by the location. It is made of field stone, and is set in the midst of the woods, at some distance from the group of telescopes and the administration building. It contains a living room, kitchen, and two bedrooms on the ground floor. On the second floor are two dormitories, large enough to accommodate four or five persons each. The cottage was built entirely for vacation purposes, and is not for the use of observers during their periods of work on Oak Ridge.

SOME OBSERVATORY TELESCOPES

The 60-inch and 61-inch Telescopes

With the development of problems of detailed galactic and extragalactic structure, the need for a large telescope was keenly felt. Especially was it advisable to have an instrument of great light gathering power in the southern hemisphere, for no other observatory had such a telescope in action in the south, and the peculiar richness of the Milky Way and the general sky made one a necessity. The Observatory has therefore added to the equipment of the southern station a 60-inch reflecting telescope. The mounting, of the two-pier type, is arranged for use in both the Newtonian and the modified Cassegrainian combinations. The instrument is surmounted by a rotating steel-framed turret, sheathed with red-wood.

A 61-inch reflecting telescope of the fork-type mounting is in process of construction (1932) for the Oak Ridge station. The building and turret are like those for the southern instrument. Both telescopes have numerous accessories, including spectroscopic equipment. The advantage of having such twin instruments for use in joint programs in both the south and the north cannot be overestimated.

The Photographic Doublets

A gift by Miss Catherine W. Bruce of New York in 1890 made possible the construction of a 24-inch doublet, known as the Bruce telescope. The instrument, remarkable for the size of its doublet lens, has good definition over a region of twenty-five square degrees; it is therefore especially useful in surveys of faint stars and nebulae over large areas and to faint magnitude limits. It is situated at the Boyden Station where it is used in the procuring of plates for programs involving Milky Way variable stars, proper motions, and external galaxies.

A number of other photographic doublets are in use at both stations. Among them are the two 8-inch telescopes mentioned above, and a 16-inch telescope, the lens of which was the work and the gift of the amateur astronomer, the Reverend Joel H. Metcalf. The 16-inch has been used extensively in charting the Kapteyn Selected Areas and the Harvard Standard Regions.

The "Great Refractor"

The telescope of the most historical interest in the Observatory is the 15-inch equatorial, known at the time of its construction as the "Great Refractor." For eighty five years this instrmuent has played an important part in the observational programs of the Observatory. At the time of its erection it was one of the largest and most impressive telescopes in existence. It formed in the early years of the Observatory's history the nucleus around which the institution grew. It furnished much of the impetus and inspiration for the laborious

observations that played a large part in the foundations of modern astronomy.

With the 15-inch, stellar photography saw its beginnings. The telescope was the first to take a picture of a star with the daguerreotype method. The instrument, however, has a lens corrected only for visual rays and did not serve effectively in photographic work. It was used with remarkable efficiency for visual observations; but at present it is not occupied with any systematic observing programs.

Other Instruments

Before photographic astronomy assumed importance far exceeding visual work, the Harvard meridian circle was a much used and highly productive instrument. Situated in a room especially constructed for it, this instrument, which is not now in active use, was employed for many years in positional observations of stars. With the 15-inch a number of photometers were used, many of which were devised by Professor Pickering for the determination of stellar magnitude.

An interesting instrument now in active use is the 12-inch polar equatorial. (See title-page drawing.) The telescope itself remains fixed, except for axial rotation, and the stars are brought into the field by means of a movable mirror. The axis is parallel to the earth's axis, and the observer looks into the eyepiece in the direction of the south pole. Placed on the south side of Building A, the telescope has its observing end fixed in a window of a second-floor room; the observer is thus seated within the room, always in the same place, and looking in the same direction. With the exception of a region around

the north pole, all of the sky to the southern horizon is visible. The telescope is used extensively for visual observations, principally of variable stars.

Other important telescopes are the half dozen small instruments of wide field, used in general and constant patrols of the sky. Each patrol camera covers an area of twenty or thirty degrees on a side, and photographs stars to the thirteenth magnitude; the plates of the AI series, taken with a $\frac{1}{2}$-inch Ross lens, show only tenth magnitude stars. The programs of these patrol instruments are so planned that they systematically cover the sky at regular intervals. Their plates are valuable in the recording of various phenomena, and are used in searching for early records of newly discovered objects, as well as for the photometry of the brighter stars.

THE PHOTOGRAPHIC COLLECTION

It was easy to realize, with the rapid development of photographic astronomy, the great advantages of the camera over the eye of an observer; the importance of permanent records, and of the possibility of charting in a few hours stars over large areas that visually would take months or even years to observe, was obvious. To obtain and preserve large amounts of data for the understanding of celestial phenomena, the collection of stellar photographs was begun as soon as photographic technique was sufficiently developed. Throughout the work of the Observatory, from the beginnings of the plate collection to the present day, the programs of photography have been carefully planned and systematically executed. The plates taken with each telescope are segregated into a separate series; the photographs are, primarily, classified according to the instruments with which they were made.

The variety of types of telescopes, and of the fields they cover, allows for equal diversity in purposes to which the plates can be put. There are, for instance, the large scale long exposure plates of the A series, taken with the 24-inch Bruce doublet, which are employed in an extensive survey of faint extragalactic nebulae. There are, again, the spectrum plates taken with objective prisms on various telescopes, which furnished the data for the spectral classifications in the Henry Draper Catalogue and Extension.

The plates made with the 10-inch Metcalf telescope, situated at Bloemfontein, contain the images of stars fainter than the sixteenth magnitude. They are used in the detailed study of faint variable stars in the Milky Way. The regions photographed, and the times of photographing them, are so planned that for each Milky Way Field there are long series of photographs so spaced as to afford adequate data for the determination of the light curves of the variable stars and the computation of their periods. Similarly, other series are devoted to special work; though almost invariably photographs taken for a specific purpose can be utilized for many other problems.

There are over 350,000 plates in the Harvard collection. With the combinations of chart and spectrum plates, of plates giving photographic and those giving photovisual magnitudes, and with the repeated survey of the entire sky over a period of more than forty years, the collection furnishes information for unlimited researches. It assists equally in the detailed examination of individual stars, and in the surveys of the higher sidereal organization of the metagalactic system. It furnishes an indefinitely large amount of information for the study of galactic structure. This collection is perhaps our most powerful aid in the plunge into the depths of space by which we hope to know something of the constitution of the sidereal universe.